EA Southern

Environment Agency Kent Area
The Seabrook Stream

BSc (Hons) Environmental Biology placement report
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CONTENTS

1 ABSTRACT

As part of the Bsc (Hons) Environmental Biology degree course, the sandwich placement students are required to undertake a project which coincides with work frequently carried out by the industry the student is working for.
During the period of August 1997 to August 1998, I worked as a student Biologist as part of the Biology Team for the Environment Agency's Biology Laboratory based at Addington in Kent.

2 SUMMARY

This report details the biological survey carried out on the Seabrook Stream, near Hythe, at the request of Kent Area Water Quality.
An introduction about the biological and chemical nature of streams and description of the Seabrook Stream itself, is followed by the results and conclusion of the survey and what outcome was achieved as a result of the biologists findings.

3 AIMS AND OBJECTIVES

The main aim of this report is to explain the type of work I carried out while working in the Kent Biology Laboratory and to give an insight of how the knowledge I gained during the year can be put to practical use. This was achieved by undertaking a project in conjunction with an investigation the Environment Agency's Biology Laboratory was interseted in.

4 INTRODUCTION

4.1 The Chemistry and Biology of streams

External and internal influences affect stream water chemistry. External influences include: seasonal changes in discharge regime, precipitation inputs and biological activity. Internal processes, which depend on the physical, chemical and biological conditions occurring in streams will also affect the water quality. Some main processes include: water turbulence, evaporation, adsorption on sediments, primary production, and oxidation of organic matter (Chapman, 1996).

When CO_2 dissolves in pure water, a small fraction is hydrated to form carbonic acid. Stream water usually contains bicarbonate and carbonates, and H_2CO_3 which readily dissolves calcium carbonate rocks, forming calcium bicarbonate (Baird, 1995).

The buffering capacity of water is critical to the maintenance of life. In freshwater the $CO_2 \leftrightarrow H_2CO_3 \leftrightarrow CO^{2-}{}_3$ equilibrium serves as the major buffering mechanism, with minor contributions from other sources (Allan, 1995; Fifield & Haines, 1995).

Dissolved gases and solids

The composition of gases in surface water is similar to that in the air, but will also depend on factors such as chemical and biochemical reactions, and the leaching of rocks and soils. The concentration of CO_2 and O_2 is particularly dependant upon the photosynthetic activity of aquatic plants and plankton, and on the interaction of other components such as temperature and microbial activity (Dojlido et al, 1993).
Dissolved oxygen and carbon dioxide , in a small stream that has not been affected by pollution, will remain near to saturation by diffusion. Although concentrations will change seasonally and daily, saturation will remain near to 100% (Allan, 1995).
The content and proportion of the main ions depends greatly onthe chemical composition of the geology and soil in a drainage area, and on the surrounding land use (Chapman, 1996; Dojlido et al, 1993). A broad relationship between composition of stream solutes and the type of rocks underlying a catchment, can be expected (Ward & Robinson, 1990).
Table 2.1 shows the variation of selected dissolved constituents in pristine streams.

Variability of dissolved major elements in pristine waters

	Conductivity (uS cm^{-1})	pH	Sum of cations (ueq l^{-1})	SiO_2	Ca^{2+}	Mg^{2+}	Na^+	K^+	Cl^-	SO_4^{2-}	HCO_3^-
Granite	35	6.6	166	9.00	0.78	0.38	2	0.3	0	1.5	7.8
Sandstone	60	6.8	223	9.00	1.8	0.75	1.2	0.82	0	4.5	7.6
Shale			770	9.00	8.1	2.9	2.4	0.78	0.7	6.9	35.4
Carbonate	400	7.9	3,247	6.00	51	7.8	0.8	0.51	0	4.1	195

Source: Meybeck, 1986
Note: all figures in ppm unless otherwise stated

The partition of substances between dissolved and insoluable forms varies, and depends upon a number of factors including the type of substance, its solubility, the adsorption

capacity of the solid material, the tendancy for substances to form complexes, pH , temperature, ionic strength, and the water composition.
These factors can change as a river progresses from its source to the sea. The occurrence of a substance in its varied species is becoming increasingly important when assessing the impact a pollutant may have on a receiving water (Dojlido et al, 1993)

Nutrient dynamics

Most materials in water systems are transported as solutes in the water column, although phosphorus, hydrophobic oganics, many trace metals ,and often nitrogen are transported mainly as particulates. A number of processes affect solutes including: transformation from one chemical species to another; physical changes such as adsorption, desorption and chemical precipitation; and biological uptake and release.
These transformations, which are associated largely with streambed processes, are mechanisms of retention. Transport of solutes also occurs within the streambed in sub-surface water, and exchange between channel and interstitial water which can influence solute dynamics (Allan, 1995).

Nutrients are the solutes which are essential to the growth and reproduction of some organisms (Webster & Ehman, 1996). Some uptake of nutrients is by physical-chemical sorption of sediments, such as phosphorus. High flows will reduce the oppurtunity of biological uptake, while increasing downstream transport and low flows will increase the oppurtunities for uptake.
Stream flow is a complex matter and a single stretch will include parcels of water each moving at very different speeds (Moss, 1980).The mean flow rate is lower in the upper regions of the stream compared to the downstream sections but the range of current speeds is narrower, so thet flows do not often fall to levels where silt or even heavier sand and gravel may be deposited. (Newson, 1994).

Bemthic Invertebrate Fauna

Freshwater macroinvertebrates are widespread, with even the most polluted or environmentally extreme lotic environments usually containing some members. The macroinvertebrates (approximately >0.5 mm; Cummins 1975a) stand as the link between algae and micro-organisms, which serve as their primary food source, and the fish and other vertebrates for which they are prey.
Macroinvertebrates are used to assess biological quality due to them being large enough to be observed with the unaided eye, abundant enough to be readily colleced and have a lifecycle of suitable length (several weeks to 1 or 2 years) for short term seasonal or annual field investigations and are sensitive to different degrees of pollution.
Most are associated with surfaces of the channel bottom, or other stable surfaces rather than being routinely free-swimming (Hauer & Resh, 1996)
Species composition will change between headwaters, middle reaches and large water sources, in response to changes in the stream environment.

Chemical factors on the biota

Although freshwater is highly variable in its chemical composition, the biological importance of such variation is only evident at the extremes, and where human pollutants are substantial.
The other important factor affecting animals is the hardness of the water. Swiftly flowing waters, with eroding substrata, may be either hard or soft, but the more sluggish lowland reaches of rivers, which have depositing substrata, have on the whole relatively hard water. Some animals, particularly those which form shells, require at least a minimum amount of calcium, which is about 20 mg/l, and therefore are more commonly found in harder water. (H.B.N.Hynes)

Stream sediments

The exchange of substances between the water and bottom sediments also affects the chemical composition of surface waters. The nature of the sedimant changes according to the depth and the amount of chemical exchange that takes place between the overlying water and the interstitial water in the sedimants. Therefore the composition of sediments is different in flowing waters than in still waters because of the constant renewal of overlying water (Dojlido et al, 1993).

There are many factors which affect the amount of sedimant in a stream, these include: climate (precipitation and temperature regimes), topography (terrain steepness, aspect), vegetation (type and density), soils (particle size and erodibility), geology (parent material and bedrock), and anthropogenic activity. (Beschta, 1996). Benthic invertebrates can be affected by increasing suspended and deposited sediment in several ways. (Wood & Armitage, 1997):

- altering substrate composition and suitability of the substrate for some taxa;
- increasing drift due to sediment deposition or substrate instability;
- affecting respiration eg: due to low oxygen concentrations associated with silt deposition; and
- affecting feeding activities eg: increased suspended sediment impeding feeders.

River fauna

The major controlling factor in the distribution of invertebrates is the nature of the river bed. This is either 'eroding' in which event it is rock, stones or gravel, or 'depositing', in which event it is silt or mud. The intermediate condition, sand, forms a convenient dividing line as it is a a particularly unsuitable habitat for animal life, and is often almost barren.
The type of river bed also correlates to the oxygen content of the water, and its temperature. Eroding substrata occur in turbulent water and usually in the upper reaches of rivers or near springs in the lowlands, so they are well oxygenated and usually cool. Depositing substrata, occur only in sluggish water and usually at low altitudes; they are therefore liable to be deficient in oxygen, and in the summer-time be warm.
The inhabitants of the 'eroding' river beds are a rich assortment of worms, leeches, shrimps, insects, mites and molluscs. They have varied ways of life but all have the common ability to withstand the force of the current. The flatworms, segmented worms, the nymphs of the stoneflies *Leuctra* and *Chloroperla* and the cranefly larva *Dicranota*, avoid exposure by creeping down amongst the stones and gravel. Other inhabitants, such as the mayfly nymphs of the family Ecdyonuridae are flattened and lay close on the stones, though at times they may take shehter beneath them. The freshwater limpet, which is the only snail found in swift flowing water, have large flat feet, which similar to the mayfly nymph allows it to be attached firmly to the stones.
Other insects are provided with stout claws, with which they cling to small irregularities on stones; these are found on stoneflies, on caddis-worms of both cased and caseless types, midge larvae (eg. chironomides) and on mayflies such as Baetidae.

The inhabitants of 'depositing' substrata are less varied and interesting, and, apart from the carnivorous alderfly, Sialidae, are all mainly scavengers.
Silt and mud are unsuitable substrata for algae, and the main foodstuff available id the silt itself, dead leaves and other decaying organic matter. Due to the sluggish current the percentage saturation with oxygen during the summer may fall at times to quite low levels, therefore only animals which can tolerate these conditions are able to survive. On the surface of the mud the water-slater Aselidae, which feeds on dead leaves and bacterial growths lives and in the mud, burrowing creatures and sometimes large numbers of bean-shrimps (Ostracoda) occur. Also to be found in such places are the large mussels Anodonta and Unionidae,although the latter does occur in sand and fine gravel.
Where the silt is coarse rather than muddy the burrowing nymphs of the fisherman's mayfly Ephemeridae are found along with great numbers of tiny mayfly nymphs, Caenidae.
Most of the depositing substrata animals live actually in or on the silt or mud; but on solid objects such as sticks, stones, bridges etc. other creatures are found which need

shelter or a solid substratum. These include the sponges *Spongilla* and *Euphydatia*, several species of flatworm, such as *Dendrocoelum*.

River flora

The presence of macrophytes on eroding substrata has little influence on the composition of the fauna, although it greatly increases the density of the animals, because many species of worms and insects profit by the abundance of shelter and food from the plants. This applies particularly to moss and a lesser extent to *Lemanea*, *Ranunculus* and *Myriophyllum*. Creatures whose numbers are always increased by the presence of macrophytes include the stonefly, Leutridae, the mayflies, Baetidae and Ephemerellidae, beetles of the family Elmidae, and the midge larvae, Chironomidae.
Where emergent vegetation is present along the banks of stoney rivers and streams similar increases in invertebrate populations occur, and a few extra species may appear. These include the stoneflies Nemouridae and Taeniopterygidae and the mayfly, Leptophlebiidae. In hard water where there is a fringing bank of water cress or water parsnip there are often enormous populations of Gammaridae.

The macrophytes which develop on depositing substrata, profoundly alter the animal population, as they greatly increase the area for shelter and also allow the abundant growth of algae in reaches of rivers where their occurrence would otherwise be very limited. Weeds provide habitats for many species which can tolerate low oxygen contents at times, but which are unable to live in bare mud or silt. Among these is the mayfly Leptophlebiidae, the dragonfly Agriidae, the snail Physidae and the pea-mussel Sphaeriidae, which clambers about on the plants with its long tongue-like foot.

Pollution

The influence of polluting substances on natural water systems can be very variable according to the substances themselves and the conditions and organisms within the water body concerned. Pollutants can act in three ways:

- by settling out on the substrate and smothering life there,
- by being acutely toxic and killing organisms directly,
- or by reducing the oxygen supply so much as to kill the organisms indirectly.

The most common pollutants of water are high levels of organic matter, plant nutrients, suspended mineral particles, deoxygenating substances and heat, and even small quantities of poisons like heavy metals, pesticides, some organic chemicals, acids and radioactive substances. Few are entirely new to living organisms, with the exceptions of some synthetic chemicals, most are found naturally discharging

somewhere in the world, and specialised communities of living organisms have evolved to tolerate them.
Conditions created by pollution from human activities tend to be more extreme, but only to a certain degree when taking into consideration other forms of natural pollution Thus the discharge of raw sewage, or blood from a slaughter house, to a river creates conditions parallel to the dunging of a water hole by large mammals in the dry savannah regions, or the washing of an animal corpse into a stream or small river. The leaching of agricultural fertilisers, or discharge of plant nutrients in the effluent from a sewage treatment works are entensions of the conditions in naturally fertile catchments, and the suspension of fine particles washed from china clay or other mineral workings is a normal feature of the streams draining mountain glaciers.

In all such natural habitats a living community is present. This does not mean that grossly polluted habitats should be accepted but it does mean that suitable organisms can be harnessed to treat some pollutants biologically, as happens in sewage treatment, or where specifically adapted organisms may be used as indicators of pollution where chemical analysis is inadequate to detect small concentrations or intermittent discharges.

The main polluting factors are organic matter, heat, plant nutrients, and the one of great interest here, heavy metals.
Heavy metals include manganese, iron, copper, zinc, molybdenum, cadmium, mercury and lead. Most of them are toxic at any level (Cd, Hg, Pb), but some are required as trace elements by living organisms but even these above 'normal' levels can become toxic.
Normal levels of these elements in unpolluted waters are around $1 \mu g\ l^{-1}$, with zinc concentrations around $10\ \mu g\ l^{-1}$. Effluents from metal industries, oil refineries, heavy metal users and from the exposure of metal sulphides to air and water in mine waste dumps may increase these concentrations by several orders of magnitude.

4.2 The Seabrook Stream

The Seabrook Stream rises from a wooded valley below the chalk of the North Downs near Folkestone. The stream crosses a belt of Gault clay, through areas of woodland and agriculture before cutting into the lower Greensand. Here it produces a springline at the junction between the Folkestone and sandgate Beds of the Lower Greensand series and passes under a motorway and railway line, through a sandstone quarry, before finishing in a small town.
(English Nature, 1987)

Part of the Seabrook Stream is designated as a Site of Special Scientific Interest (SSSI) (national grid reference 178367) due to a high abundance of cranefly species, including four nationally scarce species, such as *Erioptera limbata* Forteen other scarce invertebrates including the Caddis fly *Rhyacophila septentrionis* which lives in the stream itself and whose larvae feed on midges; the lacewing *Osmylus fulvicephalus;* and the harvestman *Homalenotus quadridentatus* which occurs in the drier grassland further up the valley sides.
(English Nature, 1987)

Figure 1 shows the full streatch of the stream from its source a spring in Elm Gardens (NGR TR 1815 3845) , rising beneath steep slopes used for grazing and a small area of coppice woodland. It passes under a dismantled railway line, now used as a public footpath, and travels through Ashley Wood. To the South West there are large aricultural fields, which lie on a gradient of 70 metres near the road, sloping down to 60 metres at the wood's edge, and a pond joins the stream before entering Frogholt.

Figure 2 shows the biological and chemical sample site locations along the stream. The sampling sites begin at Frogholt (Site 1) where the stream runs parallel to the road, which has no through access and is predominately used by residents.
The stream passes under the A20 and M20 before entering a lagoon which is responsible for draining the motorway runoff (Site 2) along with the railway discharge (Site 3) which then flows into the stream.
The stream enters the quarry at Site 4, which is inside the SSSI 0.4 km downstream of the discharge lagoon, which can be seen in Figure 1.2 marked in yellow. The land here adjoins the Territorial Army camp (Site 5) which to the West lies Dibgate Camp at the top of a sloping field used for cattle grazing and to the East the fields are used by horses and cattle.
The stream continues to run through woodland before reaching Underhill House and Casbourne Farm (Site 6). From here it travels along Horn Street, a busy residential road and crosses under Horn Street to enter a disused fish farm (Site 7). The stream finally enters the Royal Military Canal, approximately 150m from the sea.
Newington Stream joins Seabrook Stream below the quarry and is shown on Figure 2 by site 5.

This area has undergone considerable change over the last 10 years due to the construction of the Channel Tunnel Terminal. The area marked in green on Figure 1 shows the scale of the Terminal, running approximately 3 km East to West.

Photographs showing the biological sampling sites are shown in Figure 3.

Water Quality Investigation

A water quality investigation was carried out due to reports from local residents to the Environment Agency Water Quality Office at Canterbury, of a strong odour of diesel oil coming from the Seabrook Stream. Chemical samples were taken at various points along the stream, shown in Figure 2, and analysed to identify the source of the odour.
The results of the chemical sampling identified the presence of oil/diesel, which resulted in a biological survey of the Seabrook Stream being undertaken to investigate where the oil/diesel was entering the stream and what impact it was having on the freshwater invertebrates.

The water quality of the stream was assessed with reference to its macroinvertebrate fauna at a series of sites. One upstream of the discharge lagoon, two sampling sites from the lagoon itself, which was built to settle the runoff from the motorway and railtrack and four sites downstream to a distance of 2.5 km.
Invertebrate samples were collected at each of the seven sites.

5 METHODOLOGY

Locations of the seven sampling sites investigated are shown in Figure 2, site details and physical characteristics are summerised in Table 1.
The Environment Agency Kick/sweep method was used to collect a representative sample of the benthic fauna at site 1 and sites 4 to 7.
For sites 2 and 3 the Environment Agency dredge/sweep method was used due to the depth of the water. Samples were preserved in Formalin then returned to the laboratory for sorting and identification to BMWP family analysis.
The taxa were recorded using a semi-log abundance scale:-

Count	*Log abundance*	*Count*	*Log abundance*
1	1	101-1,000	4
2-10	2	1,001-10,000	5
11-100	3	10,000	6

BMWP and ASPT levels were determined, which reflect the biological quality and environmental conditions.
Appendix 4.1 summarises water quality assessment using freshwater macroinvertebrates

5.1 Field Observations

Upstream of the discharge lagoon (site 1), the stream had a substrate of gravel overlying clay with some silt but with little macrophyte cover.
The discharge lagoon itself (site 2 and 3), had a substrate of clay and silt with some oil being found in the sediment and a black layer of lubricating oil covering the water surface at the railway discharge end of the lagon
Some macrophyte cover was present at the railway discharge end, including filamentous algae, Carex sp, *Lemna minor* and *Potamogeton crispus* all of which were present in low abundance.
The motorway discharge end supported a higher abundance of macrophytes including, *Apium nodiflorum,* filamentous algae, *Ranunculus sceleratus, Phragmites australis,* and *Potamogeton crispus.*

Downstream of the discharge lagoon at site 4, there was an oil boom which suggests that this has been affected by oil pollution at some point. On the day the sample was taken there was no smell or sight of any oil present.
Further down stream at site 6, there was again no sight or smell of oil but over the last few weeks, local residents have mentioned a distinct smell of diesel in the air.
Oil booms were again seen at site 7, both upstream and downstream of the sample site.

Results

Biology

Table 2 and Graphs 1a, 1b and 1c show the invertebrate taxa found at each site, together with their abundances, BMWP scores and ASPT values.
A higher BMWP score for comparable sites, generally implies a more diverse invertebrate fauna, indicating better biological quality. The ASPT reflects the sensitivity of the species present, lower scores indicating more pollution tolerant invertebrates in proportion to intolerant invertebrates.

Chemistry

Dissolved oxygen, the biological oxygen demand and ammonia, are the three variables required for allocating chemical quality class for a river. These three variabes are summerised in Graphs 2a, 2b and 2c respectively, for the two chemical sampling sites on the Seabrook Stream (upstream of the quarry- site 4, and downstream of the quarry- site 5).
Both sites have a fairly constant value for each variable, after allowing for seasonal variation, over the period of 1992 to 1995. To ensure the chemical quality was remaining constant site 5 has continued to be sampled every month upto the present day.

Due to the concern of oil/diesel overflowing from the discharge lagoon, chemical samples were taken for Gas Chromatography analysis to identify what type of oil/diesel was entering the stream and to what distance was it travelling down the stream.
Chemical samples were taken at the inlet and outlet of the lagoon and at site E (downstream of the quarry), twice in July and once in August 1997 (Table 3).

DISCUSSION

Macroinvertebrate Survey

SITE 1

The biological quality as indicated by the macroinvertebrate fauna of the Seabrook Stream, upstream of the discharge lagoon was found to be very good, with an ASPT of 5.25. (Site 1, Table 2). Site 1 had an invertebrate fauna typical of headwater streams which included one family of stonefly (**Leutridae**) and two families of Caddis fly and mayfly, one being **Ephemeridae**. The high species diversity, along with the presence of pollution intolerant species, suggests that this stretch of the stream has not been excessively polluted.
Only one **Chironomidae** (Diptera) was recorded at this site. This species are tolerant of organic pollution and are found abundant in muddy stream beds, which may explain there absence at this site which had a gravel substrate. Although a very low abundance was seen at this site, their presence may be indicated by the leech **Erpobdellidae**, whose food source is Diptera larvae. (Site 1 -photoA)

SITES 2 and 3

Sites 2 and 3, which were both sampled from the lagoon had a very poor water quality, which was to be expected due to the sediment and surface being covered with oil/diesel.
The high scoring, intolerant taxa found at site 1, were absent from both of these sites but only seen at sites 2 and 3 was the damselfly family, **Coenagriidae** which was present in relatively abundant numbers. This is probably due to damselflies occurring in most types of wetland, including brackish water and bogs which lagoons are similar to, due to the increased salt content from the motorway run-off. The lagoon is fairly stable with a well established vegetation which would also attract the damselflies. In both sites there was a high abundance of two families of snails, **Lymnaeidae** and **Planorbidae** and the true worms, **Oligochaeta** all which are very tolerant to pollution. (Site 2 and 3 -photo B and C)

SITE 4

The total BMWP score drops from 63 to 53 from site 1 to site 4, with an ASPT of 5.25 to 4.08. The sample site is situated in dense woodland, lying within the SSSI, with little human interference. However, this site is on the edge of the quarry and only 0.4 km downstream of the motorway and railtrack lagoon. Downstream of the lagoon at site 4 a reduction was seen in the number of taxa, BMWP score and ASPT, compared with site 1. The lower abundance of pollution intolerant species indicates a fall in the biological quality, with the stonefly **Leutridae** and mayfly **Ephemeridae** being absent.
Taxa such as chironomid midge larvae, true worms which are all lower scoring taxa, were abundant. (Site 4 -photo G)

SITE 5

Site 5 which was 0.7 km downstream of the lagoon 0.2 km downstream of the quarry had a slightly improved biological quality compared with site 4. The impact of the quarry on this

site must be taken into consideration, with most quarries altering the local surface water. Water flows from the disturbed area can be more variable, and overland flow can be increased due to the compaction of surface and subsoils, and the loss of plant cover. Impacts of mining on invertebrates can include: increased turbidity from the non-settling fraction; blanketing of substratum; increased drift due to sediment deposition or substrate instability; affects on respiration due to low oxygen concentrations; and affects on feeding activities (Wood & Armitage, 1997; Down & Stocks, 1977).
The site supported high scoring taxa such as the stonefly, **Nemouridae** and the Caddis fly, **Rhyacophilidae** and therefore a conclusion can be drawn that the quarry was having no harmful effect on the stream. (Site 5 -photo I)

SITE 6

Site 6 had a slightly poorer biological quality than site 5 due to high scoring taxa, such as the stonefly, **Nemouridae** being absent. The families present were similar to those found at the previous site. The reduction in the number of taxa found and the reduced BMWP score, compared to site 5, was surprising considering the site had an ideal gravel overlying sand substrate for the invertebrates. (Site 6 -photo J)

SITE 7

Site 7 has an even poorer biological quality mainly due to its change in substrate compared with the other sites. Also by this site the stream had flowed through an urban area, which could have harmful effects on the invertebrate life. (Site 7 -photo K)

Results from the macroinvertebrate survey show a decline in the biological quality of the Seabrook Stream from the headwater site to the sites downstream of the discharge lagoon.

From the results of the chemical sampling no oil/diesel was found at site 1 (upstream of the lagoon), at the inlet and outlet of the lagoon hydrocarbons C12 - C23 were present indicating slightly weathered diesel/ heating oil, and downstream of the lagoon at chemical site E, a heavy lubricating type oil, and a trace of weathered diesel / heating oil was found to be present (Table 3).

CONCLUSION

The chemical monitoring did detect levels of oil/diesel in the Seabrook Stream but not anything that would indicate chronic levels of chemical pollution. The local hydrology has been considerably altered since the building of the Channel Tunnel Link, resulting in an increase in rapid runoff from the surrounding land. This could certainly contribute to the stream receiving bouts of pollution after a heavy rainfall.

The results of the biological survey concluded that the discharge from the lagoon was having an impact on the stream. The biological quality of the stream upstream of the lagoon was excellent with the quality deteriating directly downstream. The reason for the increase in the biological quality at site 5 and the fall at site 6 and 7 could be explained by looking at the change in substrate, along with the surrounding habitat with which the stream flowed through, being an urban area.
Therefore the main concern for the stream is the discharge lagoon constructed to contain the surface water run-off from the railtrack and motorway. The railway drainage system had initially been designed for electric locomotives and therefore was not prepared to cope with leakages and spillages from diesel run trains. The three-step settling tanks which were built to settle most of the diesel/oil before it entered the lagoon were ineffective and large quantities of diesel/oil were consequently entering the lagoon (photo D and F).
This resulted in the lagoon's surface and sediment being covered in oil/diesel and during heavy rainfall the overflow for the lagoon flowed into the Seabrook Stream. The flow of diesel/oil from the lagoon down the stream after heavy rainfall, was the likely cause of the macroinvertebrates in the stream suffering a delerious effect.

Aswell as looking at the effects the lagoon is having on the stream, the effects the oil/diesel is having on the life in the lagoon also has to be taken into account, especially as Great Crested Newts, *Triturus cristatus*, are known to be living in the lagoon.

Due to the findings mentioned in the discussion a meeting was arranged, for the 20th September 1998, with Railfreight, (the company responsible for the lagoon and therefore its discharge), and the Biologists and Environment Protection Officers from the Kent and Canterbury Environment Agency Officies.

As a result of the meeting it was agreed that a plan would be drawn up by Railfreight, with conference with Environment Agency staff, which would result in a positive environmental outcome to the problems the Seabrook Stream was suffering.
Firstly interceptors would have to be built which were adequate enough to cope with the quantities of discharge which came from the railtracks. Secondly the company would have to apply for an consent license to allow them to discharge a monitored and controlled amount of discharge in to the Seabrook Stream, and thirdly the sediment in the lagoon would have to be cleaned to ensure that the life remaining in the lagoon had the best chance of survival.
Due to the presence of The Great Crested Newt in the lagoon the timing of the work which needed to take place would have to work around the life-cycle of the newts in order not to harm their mating, breeding, hatching and hibernating cycle. Therefore during the Summer months the interceptors could be built at the margins of the lagoon as the newts would spend most of their time in the water but the cleaning up of the sediment would have to

wait until the following Autumn when the newts would return to the land for hibernation. This way the newts would suffer the least disturbance possible.

The Biologists believe the Seabrook Stream does not require any clean up operation because in instances such as this the biological quality of the stream, over time, will beable to recover itself, assuming no further pollution occurs. The involvement of machinery and workers cleaning up a watercourse can sometimes do more harm to the stream and its surrounding habitat than was there before, especially as the watercourse is part of a SSSI.

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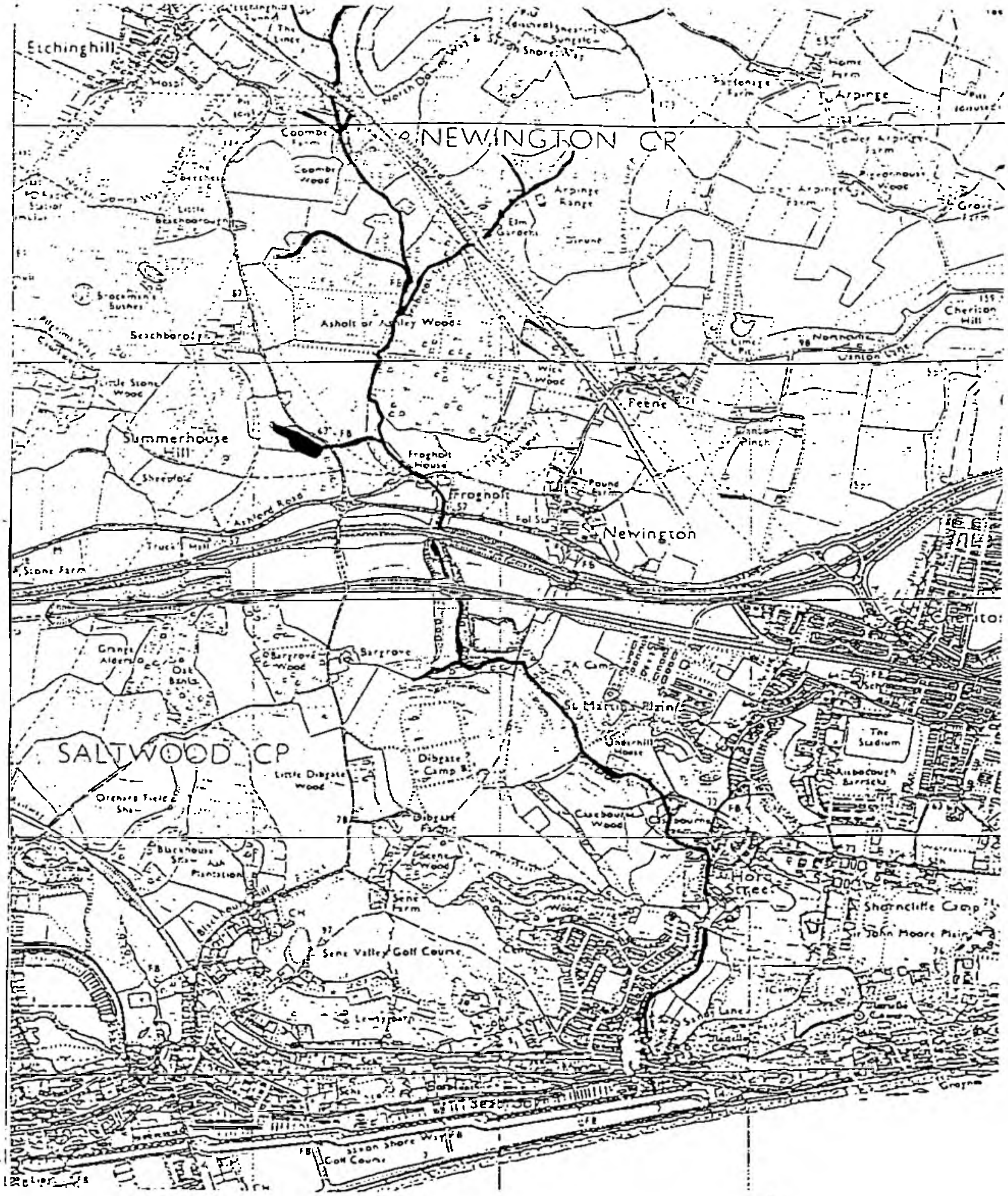
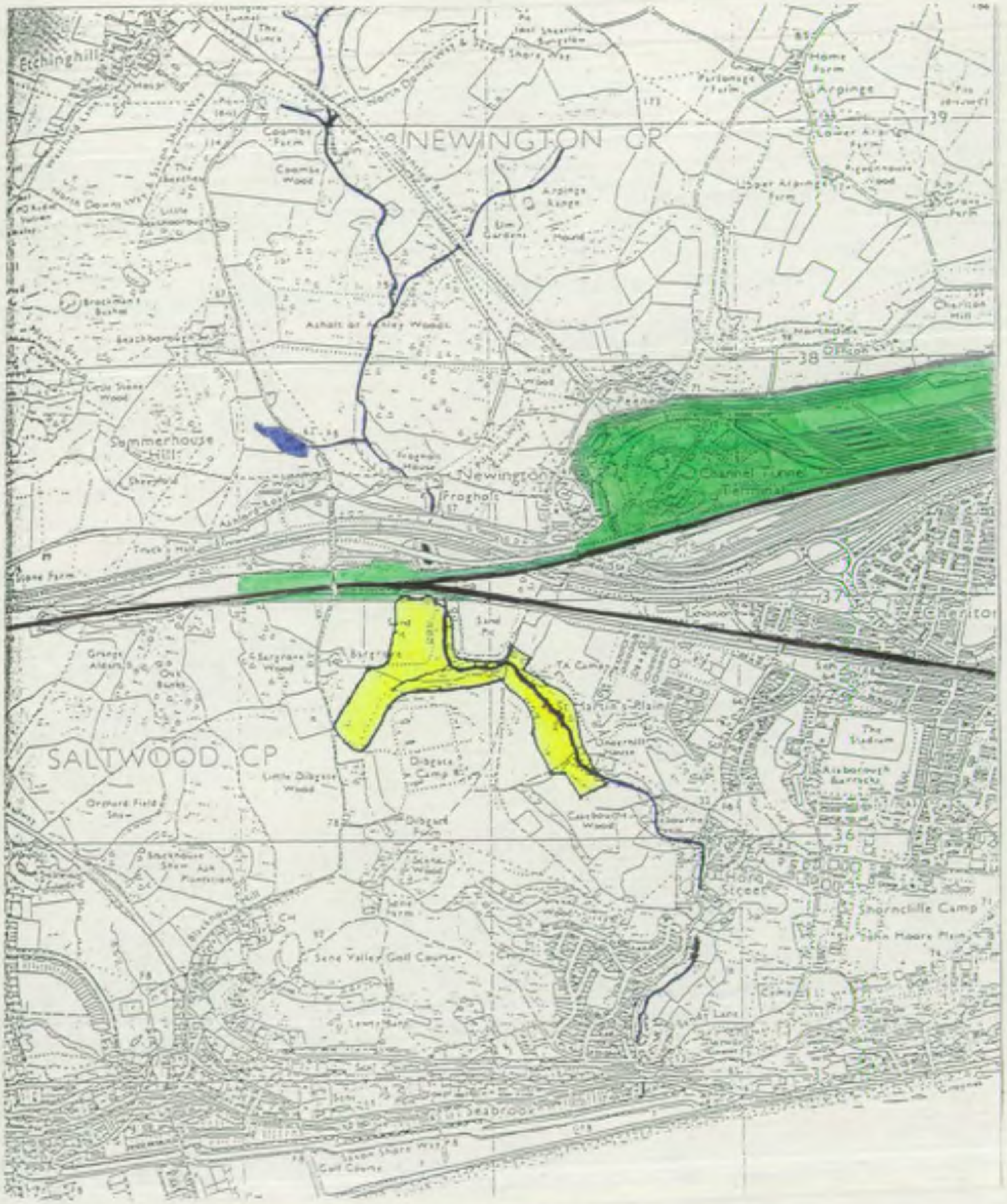
APPENDIX

FIGURES

Figure 1 ***Seabrook Stream before and after the Channel Tunnel construction***



Source : Ordnance Survey, 1982



N

Source : Ordnance Survey, 1994

SCALE 1:25,000

Figure 2 Map of Biological and Chemical Sampling Sites

TABLES

Table 1 Site Details and Physical Characteristics

Seabrook Stream Survey 1st September 1997

Site Details

SITE No.	SITE REF.	NGR	LOCATION
SITE 1	1E1369	TR 1766 3754	0.5 km u/s discharge
SITE 2	1E1370	TR 1773 3722	lagoon motorway end
SITE 3	1E1371	TR 1776 3718	lagoon railway end
SITE 4	1E1372	TR 1785 3693	0.4 km d/s discharge
SITE 5	1E1373	TR 1808 3675	0.7 km d/s discharge
SITE 6	1E1374	TR 1864 3619	1.5 km d/s discharge
SITE 7	1E1375	TR 1881 3557	2.5 km d/s discharge

Physical Characteristics

SUBSTRATE	MEAN DEPTH (cm)	MEAN WIDTH (m)	FLOW	CLARITY	% MACROPHYTE COVER	COMMENTS
SITE 1 80% Gravel 10% Silt/Clay	3.0	1.8	Mod/Riffle	Clear	2%	Gravel overlying clay
SITE 2 100% Silt/Clay	200	16	Still/Pool	Clear	0%	Thick oil layer
SITE 3	200	16	Still/Pool	Clear	0%	Thick oil layer
SITE 4 85% Gravel 15% Silt/Clay	5.0	0.75	Mod/Riffle	Clear	0%	Gravel overlying clay
SITE 5 70% Gravel 30% Sand	5.0	1.5	Mod/Riffle	Clear	0%	Gravel overlying sand
SITE 6 70% Gravel 30% Sand	5.0	1.0	Mod/Riffle	Clear	0%	Gravel overlying sand
SITE 7 50% Sand 50% Silt/Clay	8.0	1.5	Slow/Riffle	Clear	0%	deep layer of sand/silt

Table 2

LIST OF INVERTEBRATE TAXA
SEABROOK STREAM 1ST September 1997

SURVEY CODE WQ26		SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7
SITE CODE		1E1369	1E1370	1E1371	1E1372	1E1373	1E1374	1E1375
TAXA								
Ephemeridae*	The Mayfly	2						
Leuctridae*	Stoneflies	2						
Nemouridae*	Stoneflies					2		
Rhyacophilidae*	Caddis (caseless)					2	2	
Polycentropodidae*	Caddis (caseless)	2						
Limnephilidae*	Caddis (with cases)	3			1	2	1	2
Ancylidae*	Freshwater Limpets				3	3		
Gammaridae*	Freshwater shrimps	4			3	4	4	4
Coenagriidae*	Damselflies		3	3				
Elimidae*	Riffle Beetles	3			3	3	4	4
Hydropsychidae*	Caddis (caseless)							3
Tipulidae*	Crane flies				1	2	3	3
Simuliidae*	Black Flies (Biting)	2						
Planariidae*	FLATWORMS				2	3		3
Dendrocoelidae*	FLATWORMS							1
Baetidae*	Mayflies inc. Olives	3			3	4	4	3
Hydrobiidae*	Snails				3	4	4	2
Lymnaeidae*	Snails		4	4	3	2		
Planorbidae*	Snails inc. Ramshorn		4	4	2			
Sphaeriidae*	Pea mussels					3		2
Glossiphoniidae*	Leeches	2			2	3	2	2
Erpobdellidae*	Leeches	2				2	2	2
Asellidae*	Water Hoglouse					1		
Chironomidae*	Non-Biting Midges	1		2	3	3	1	3
OLIGOCHAETA*	TRUE WORMS	3	4	4	3	4	3	3
COLLEMBOLA	Spring Tails							1
Veliidae	Water Crickets					1		
Ceratopogonidae	Biting Midges					2		
Stratiomyidae	True Flies				1			
Empididae	True Flies						1	
Muscidae	True Flies				1			
No of SCORING TAXA		12	4	5	13	17	11	14
BMWP SCORE		63	13	15	53	73	46	57
ASPT SCORE		5.25	3.25	3.00	4.08	4.29	4.18	4.07

(* BMWP Scoring Taxa)

Table 3 Results from the chemical sampling

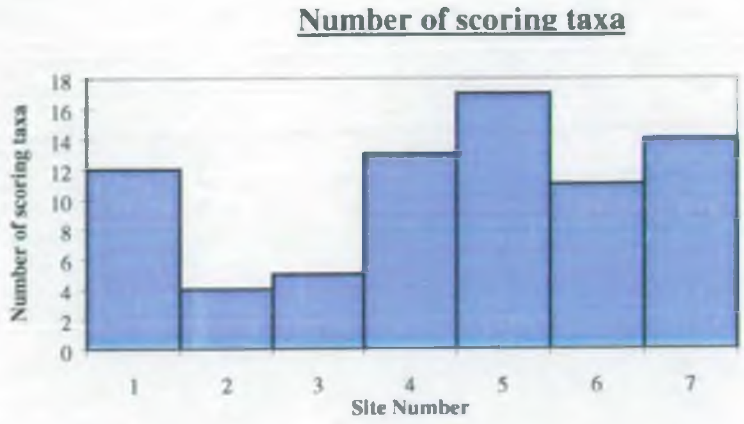
DATE	SITE A	SITE B	SITE C	SITE E
16TH JULY '97	not sampled	H C12 - C25, weathered diesel/heating oil	H C13 - C23, weathered diesel/ heating oil	heavy lubricating oil detected
16TH JULY '97	not sampled	weathered diesel /heating oil	H C13 - C24, weathered diesel/ heating oil	heavy lubricating oil detected
29 TH AUGUST '97	no oil found	no oil found	no oil found	no oil found

H = Hydrocarbons

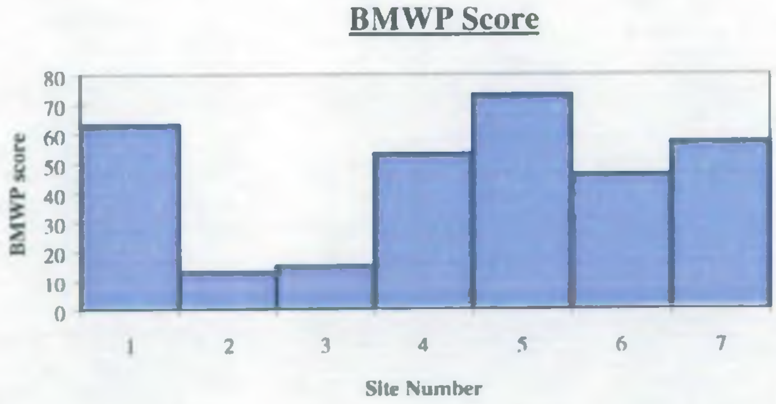
GRAPHS

Summary of the observed biological indices

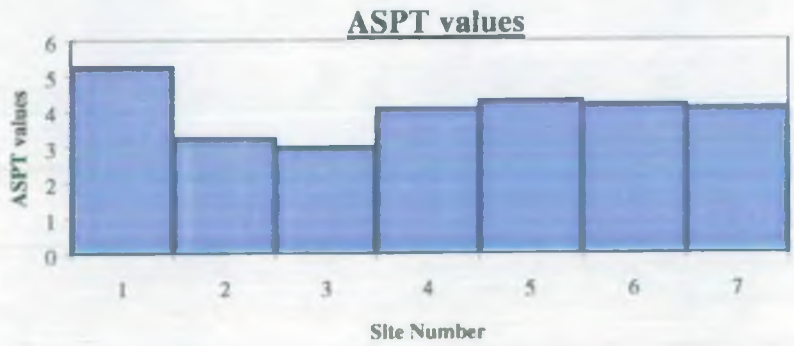
GRAPH 1a



GRAPH 1b

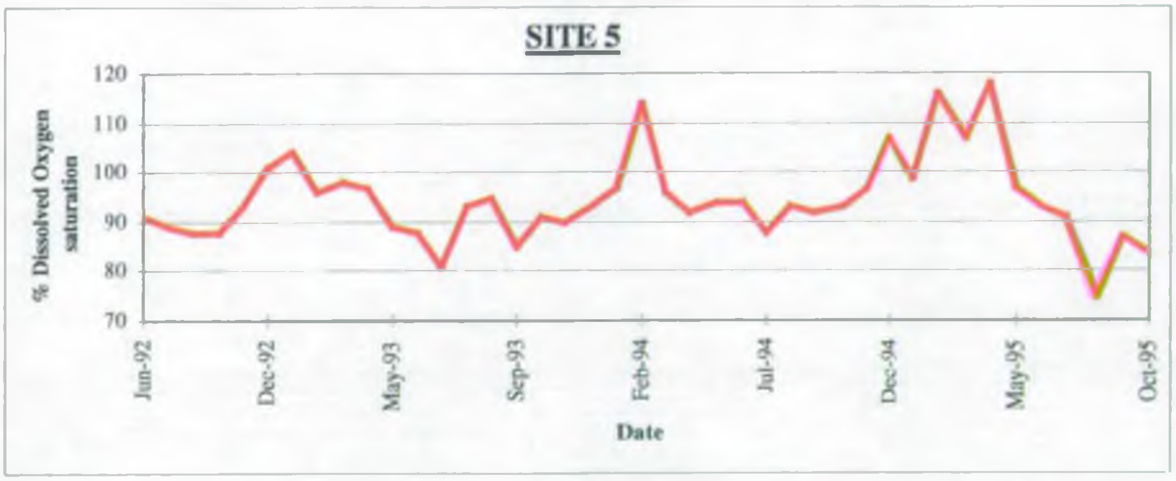


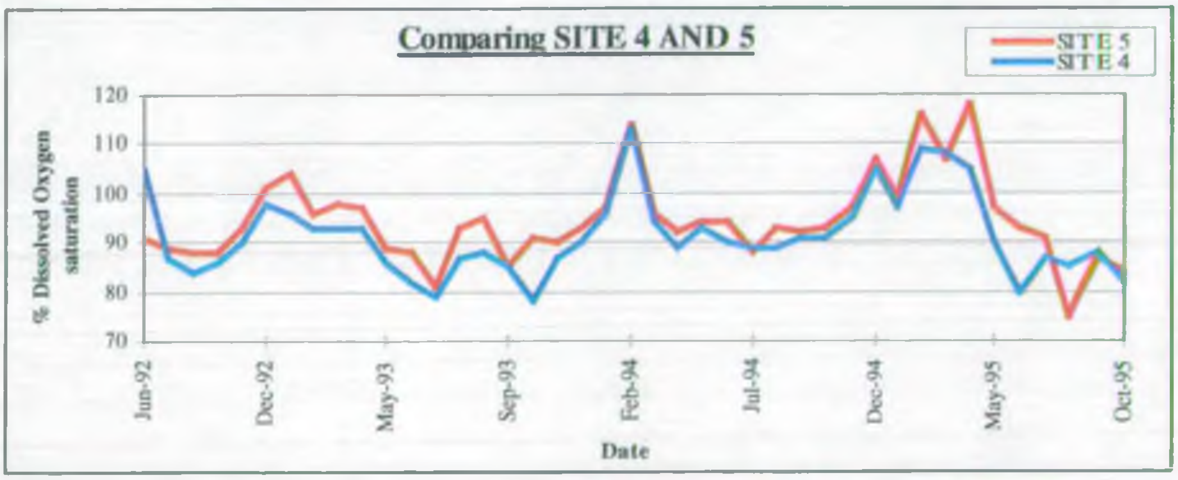
GRAPH 1c



GRAPH 2a

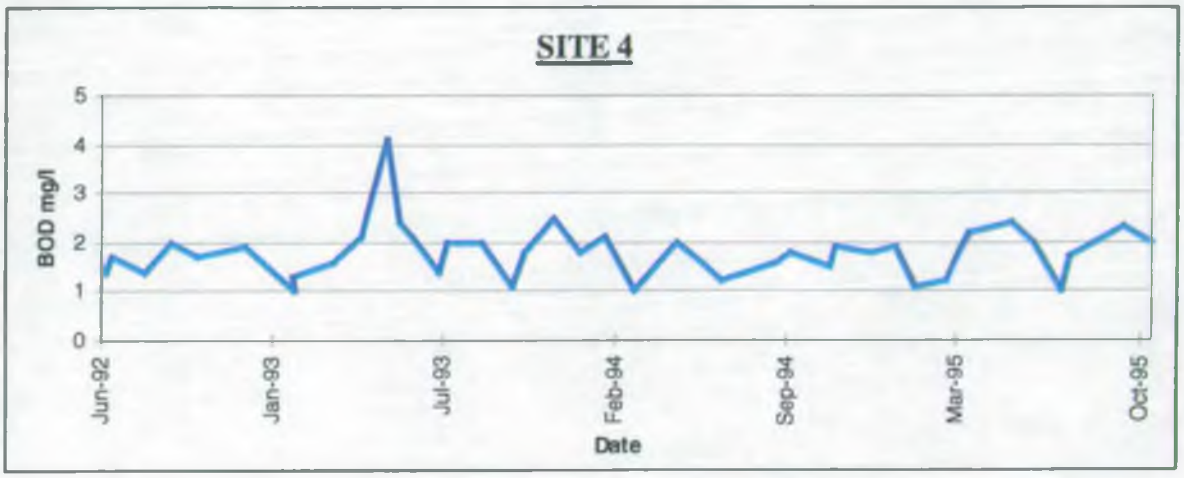
Graphs showing the percentage saturation of dissolved Oxygen for the two chemical sampling sites on the Seabrook Stream between 1992 and 1995.

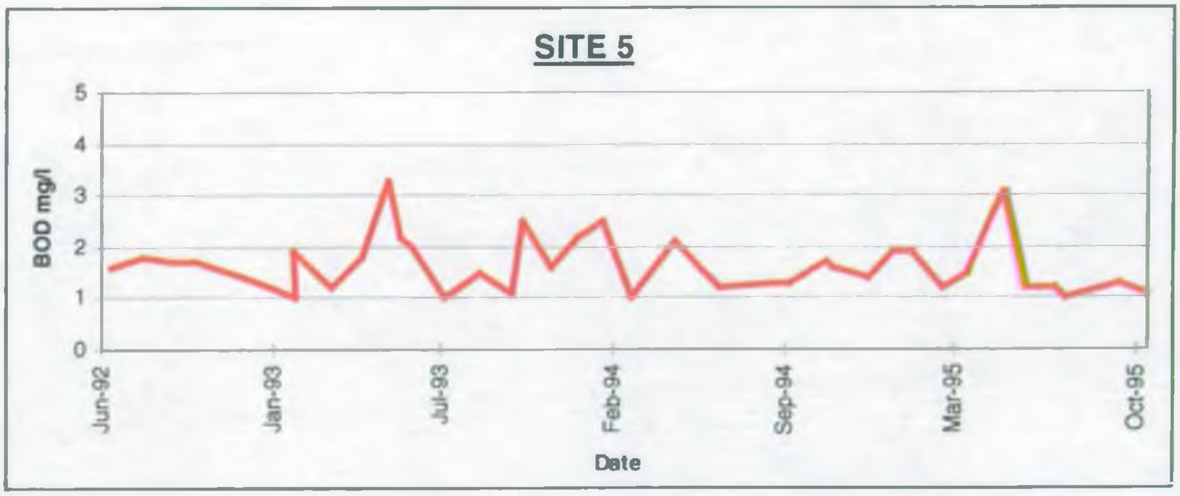


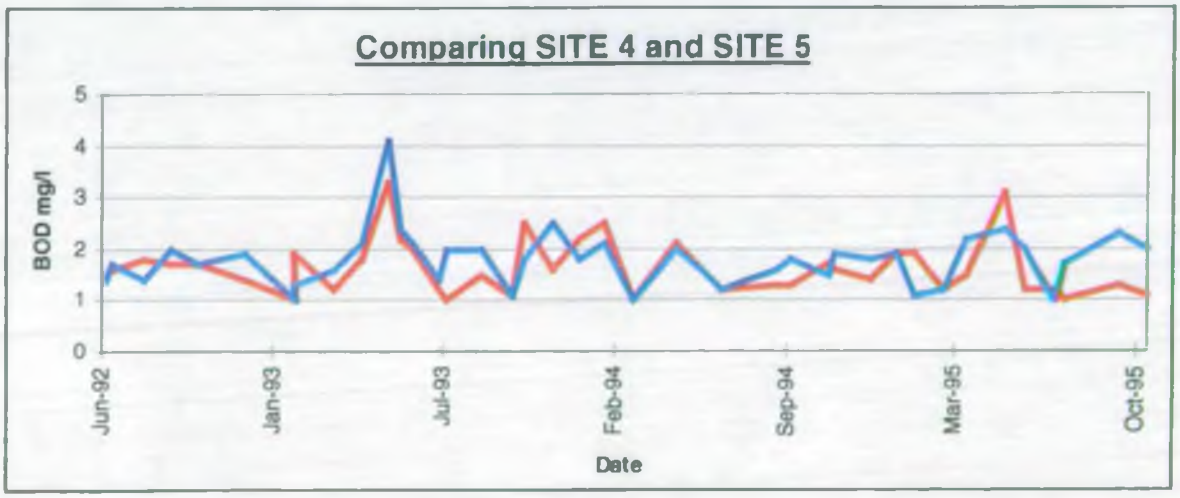


GRAPH 2b

Graphs showing the Biochemical Oxygen Demand (mg/l) for the two chemical sampling sites on the Seabrook Stream between 1992 and 1995.

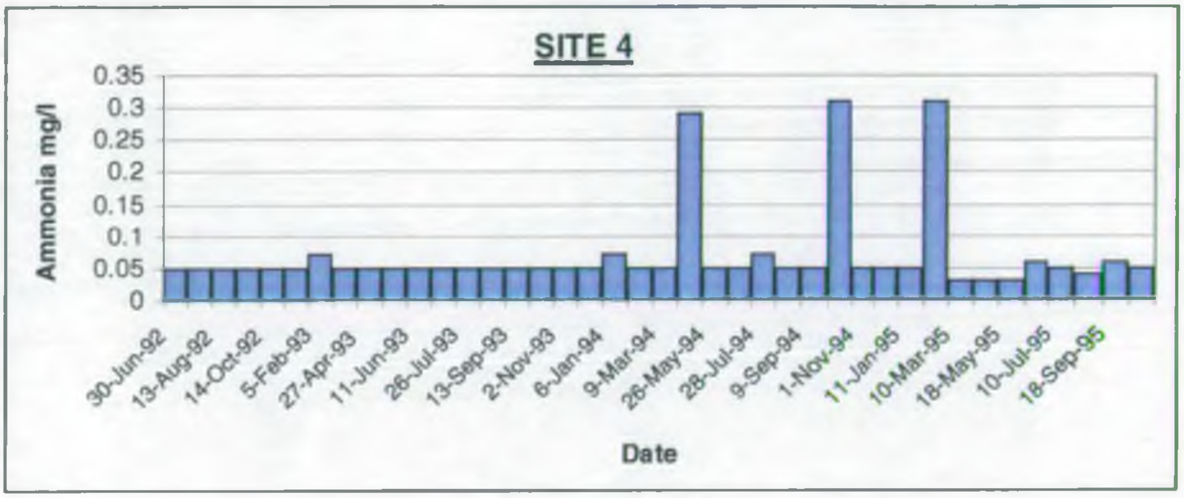


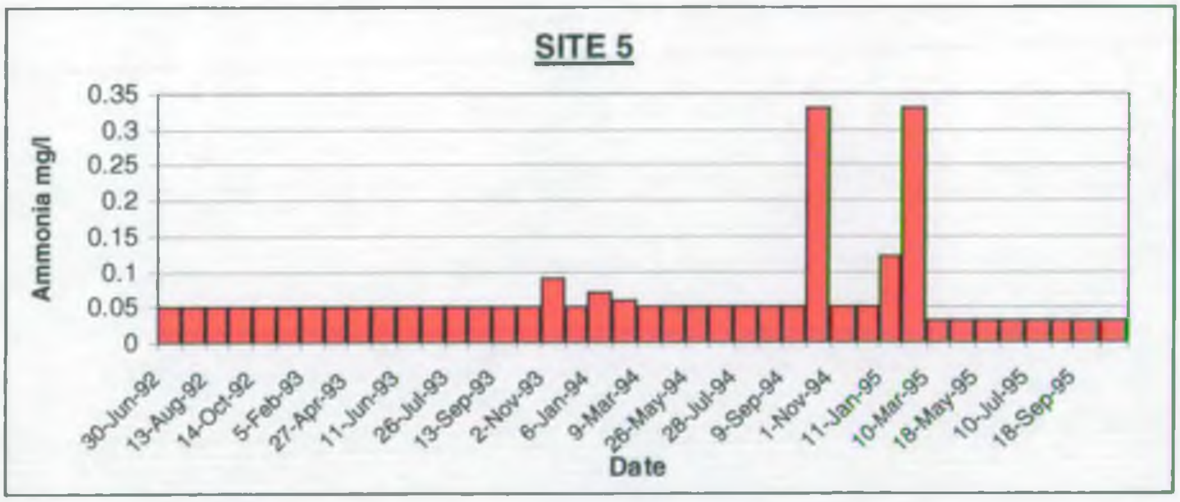


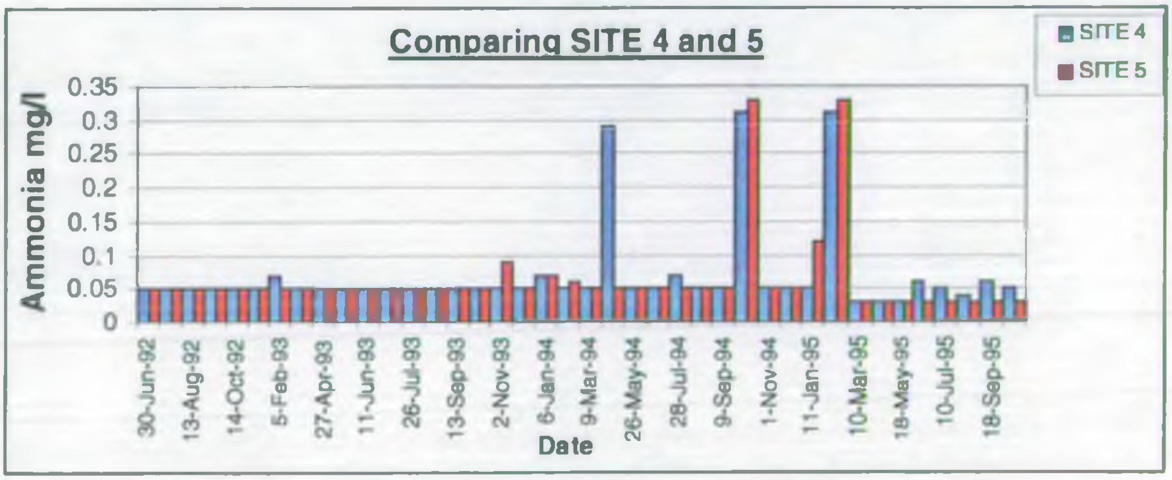


GRAPH 2c

Graphs showing the Ammonia Values for the two chemical sampling sites on the Seabrook Stream between 1992 and 1995.







PHOTOGRAPHS

Figure 3 Photographs of the biological sampling sites

Photo A, Site 1, 0.5 km upstream of the discharge lagoon at Frogholt.

Photo B, the discharge lagoon with railway and motorway discharge outlets.

Site 3

Site 2

Photo C, Site 3 where the railway outlet enters the lagoon.

Photo D, showing the 3-stage steps intending to settle out the oil/diesel before it enters the lagoon

Photo E, photo showing railway discharge inlet (bottom left) and lagoon outlet into the Seabrook Stream (top right)

Photo F, a set of three settling steps to reduce the volume of oil/diesel entering the Seabrook.

Photo G, Site 4, 0.4km downstream of the discharge lagoon.

Photo H, an oil boom was present downstream of Site 4.

Photo I, Site 5, 0.7km downstream of the discharge lagoon.

Photo J, Site 6, 1.5km downstream of the discharge lagoon.

Photo K, Site 7, 2.5km downstream of the discharge lagoon.